

FINAL PLAN

**RADIOLOGICAL CHARACTERIZATION AND FINAL STATUS
PLAN FOR BATTELLE COLUMBUS LABORATORIES
DECOMMISSIONING PROJECT
WEST JEFFERSON SITE**



505 King Avenue
Columbus, Ohio 43201

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1.0 INTRODUCTION

The Battelle Columbus Laboratories Decommissioning Project (BCLDP) is a remediation project affecting the Battelle Columbus Operations (BCO) King Avenue and West Jefferson sites. Battelle has been a contractor to the U.S. Department of Energy (DOE) since the 1940s, when it was the United States Army Corp of Engineers Manhattan Engineer District. Radioactive materials research activities including metalworking, metallurgy, radiochemistry, and testing continued until the 1980s. The BCLDP was formed in 1984 to decommission and remediate Battelle-owned buildings containing residual radioactive materials. In addition to being a DOE contractor, Battelle is also a Nuclear Regulatory Commission (NRC) licensee. Consequently, both DOE and NRC requirements must be met during the decommissioning process.

Decommissioning is the process of removing a facility from operation, decontaminating the facility, terminating the NRC license and/or returning the facility to unrestricted use. The purpose of the decommissioning process is to “assure that future uses of any licensed facility will not result in individuals being exposed to unacceptable levels of radiation and/or radioactive materials” as stated in NUREG/CR-5849, “Manual for Conducting Radiological Surveys in Support of License Termination” (Reference 1). Radiological surveys are necessary to determine the levels of radiation/radioactive materials at a facility. Guidance regarding the planning and performing of radiological surveys in conjunction with decommissioning is provided in Reference 1 that describes six surveys relating to the decommissioning process:

- Scoping survey - identifies the potential radionuclide contaminants at the facility and the general extent of area and volumetric contamination and preliminarily identifies affected and unaffected areas. Affected areas are those that have potential contamination (based on process knowledge) or known contamination (based on previous radiological surveys). Unaffected areas are not expected to contain radioactive contamination based on process knowledge and previous radiological surveys.
- Background survey - establishes the levels of naturally occurring radiation/radioactive materials in the environment; may include ambient exposure rate measurements, determination of radionuclide concentration in soil or groundwater, and determination of radionuclide concentrations in building materials.
- Characterization survey - more accurately defines the extent and magnitude of contamination; delineates areas to be decontaminated.
- Remediation control survey - determines the effectiveness of decontamination in progress.
- Final status survey - determines the post-decontamination (if decontamination was required) condition of the facility; provides data to demonstrate that unacceptable levels

of radioactive materials have not been left on-site. Data from previous surveys may be used to supplement the final status survey.

- Confirmatory survey - confirms the adequacy of the facility's decontamination and decommissioning process and the accuracy of the final status survey. This survey is performed by an independent third party, usually referred to as the "Independent Verification Contractor (IVC)." This DOE subcontractor satisfies the certification requirements of BCLDP Procedure QA-AP-7.1, "Decontamination and Decommissioning Operations (DDO) Quality Department Administrative Procedure (QD-AP)."

This plan provides general but mandatory guidance for survey activities at the West Jefferson site. It is based upon NUREG/CR-5849, which is committed to in the NRC-approved BCLDP decommissioning plan, "Decommissioning Plan for the Battelle Memorial Institute Columbus Operations" (Reference 2). NUREG-1575 "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)" (Reference 3) may be used in lieu of Reference 2 if the final status process is determined to be a more efficient and cost-effective survey. Professional judgement will be used to determine the most efficient and effective survey design. Operations not covered by approved procedures will be described in detailed Work Instructions for each area to be characterized, as required by QD-AP-5.2, "Work Instructions."

2.0 OPERATIONAL HISTORY

The West Jefferson North site has five permanent structures included in the scope of this document; JN-1, JN-2, JN-3, JN-6, and the Well house. Three temporary structures, JNT-1, JNT-2, and JNT-3, are also located at the site. Several outfalls, filter beds, and wells are located on the site.

JN-1 is a steel frame, concrete block/brick structure containing three large hot cells, a bank of ten alpha-gamma cells, a mechanical test cell, and supporting facilities including a large storage and transfer pool. The facility was used for hot cell examination of fuel elements irradiated in the Battelle Research Reactor. Subsequent work in the facility involved examination of fuel from commercial power reactors in support of DOE programs.

JN-2 is a two-story steel frame, concrete block/brick structure with an attached high-bay area. This building contains a vault that was used to store plutonium and highly enriched uranium. The Radioanalytical Laboratory (RAL) is located in the former plutonium lab.

JN-3 is a two-story steel frame, concrete block/brick structure with a basement. The three floors are reinforced concrete and the former reactor pool/containment is also concrete. The research reactor that was located in this building was used in support of fuel development programs. It was partially decommissioned to NRC criteria as indicated and documented in a letter from K.D. Kok and Sam Basham to W. H. Goldthwaite (Reference 4) regarding the report, "Dismantling of

the Battelle Research Reactor (BRR)” (Reference 5), and the letter from Kenneth Kok to Joel Kohler regarding the description of the final survey of the BRR (Reference 6).

JN-6 is a brick building that housed Battelle’s West Jefferson security operations.

The Well house is a brick building with a basement that contains the equipment associated with supplying water to the site.

JNT-1, JNT-2, and JNT-3 are mobile home trailers used as office/break areas.

The principal form of material present at the West Jefferson site is irradiated enriched uranium and associated long-lived fission and activation products, which would include all nuclides listed in Table 5 of DD-93-03, “Volumetric Release Criteria Technical Basis Document for Battelle Columbus Laboratories Decommissioning Project (BCLDP)” (Reference 7).

Isolated areas, such as the RAL, may possibly contain nuclides from the King Avenue site. These areas are routinely surveyed under the surveillance and maintenance program and no significant decontamination efforts are expected.

3.0 SCOPING SURVEYS

Scoping surveys were performed at the onset of the BCLDP. Initial baseline areas are listed in “Submission of Report on Facilities for Acceptance Under the DOE Surplus Facilities Management Program” (Blue book, Reference 8), Reference 4, Reference 5, Reference 6, Argonne National Laboratory’s “Cursory Radiological Assessment Battelle Columbus Laboratory Decommissioning and Decontamination Project” (Reference 9), and the Stenhouse and Beard report, “Site Characterization West Jefferson North Site Sampling and Analysis” (Reference 10). Additional baseline areas have been added based on radiological surveys and DOE approval. Outdoor areas inside the fenced portion of the site are considered baseline, along with the abandoned filter beds and abandoned discharge pipe. Other outdoor areas will be evaluated individually. The structures on the North site, listed above, are considered baseline.

4.0 BACKGROUND SURVEYS

Background surveys in support of radiological characterization and final status surveys will be performed on materials that contain varying quantities of naturally occurring radionuclides. Surveys may need to be performed in the presence of interfering radiation fields from other natural or contamination sources. Quantification of background sources is required, for both soil and building materials, to accurately report residual radioactive contamination as stated in Reference 7.

Mean background activity for building materials will be determined by surveying areas known to be free of residual activity. These surveys will be performed in the same manner and with the

same instrumentation used during characterization and final status surveys. Chauvenet's criterion for rejection of data (Reference 11) will be applied to ensure a true mean background is acquired. A decision level value (DLV) will be calculated to permit identification, in the field, of surfaces that require additional radiological measurements. Decision level values will be calculated by using the following equation:

$$DLV = \bar{x}_{bkg} + MDA$$

where:

$$\begin{aligned}\bar{x}_{bkg} &= \text{mean background value (cpm)} \\ MDA &= \text{minimum detectable activity (cpm)}.\end{aligned}$$

MDA values will be calculated using the following:

$$MDA = 3 + 4.65(\sigma_{bkg})$$

where:

$$\sigma_{bkg} = \text{standard deviation of background value.}$$

Mean background activity for soil will be determined by taking samples in areas known to be free of residual contamination. These samples will have the same characteristics as the soil in the areas to be characterized and will be analyzed for the known or suspected site contaminants. Soil screening may be used to expedite the survey process and reduce analytical costs. Soil screening is accomplished by placing the soil sample in a known geometry and counting the sample with a scintillation detector. The sample reading is compared to the DLV for soil and is sorted into one of three categories; "clean," "suspect," or "contaminated." The DLV for soil screening is derived by screening several background samples and obtaining the mean using Chauvenet's criterion. All samples whose screening is less than the mean (\bar{x}_{bkg}) plus two standard deviations (σ) are "clean." Any samples whose screening is greater than MDA are considered "contaminated." One hundred percent of samples classified as contaminated are sent to the RAL for analysis. Approximately 5 percent of the soil samples that screen as clean will be analyzed for quality control purposes.

5.0 BUILDINGS AND FACILITY SURFACES

For a facility to be released for unrestricted use without radiological controls, characterization, remediation controls, and final status surveys must be performed to ensure that residual radioactive contamination levels are below BCLDP release criteria found in Reference 7 and the "Surface Release Criteria Technical Basis Document for Battelle Columbus Laboratories Decommissioning Project (BCLDP)," (Reference 12).

5.1 Characterization Surveys of Facility Surfaces—Baseline Areas

Radiological characterization surveys are used to determine the quantity and extent of residual radioactive contamination. Areas that exceed acceptable levels of residual contamination, according to Reference 7 and Reference 12, will require decontamination. As Low As Reasonably Achievable (ALARA) considerations may result in the remediation of additional areas that otherwise meet the release criteria. These areas will be evaluated by the Characterization Project Manager or designee, Remedial Action Manager or designated Project Manager, and Safety personnel prior to the beginning of characterization activities.

Preparation of areas for characterization will include equipment removal, floor/ceiling tile removal, or other activities necessary to expose building surfaces and limit the exposure of personnel to hazardous conditions. Characterization surveys will be conducted using BCLDP Procedure DD-CP-004, "Radioactive Contamination Monitoring Requirements for Facility Surface Characterization." DD-CP-004 requires that baseline building areas have exposure rate measurements and direct and indirect surveys conducted as part of the characterization process.

The BCLDP plans to monitor the underground drains using the Pipe ExplorerTM, which is owned and operated by Science and Engineering Associates, Inc. (SEA). Underground drain lines with activity meeting or exceeding release criteria will be excavated and removed. Soils surrounding the radioactively contaminated drain lines will be surveyed as described in Section 5.2.2 of this document.

5.1.1 Exposure Rate Measurements

Exposure rate measurements will be conducted to ensure that the exposure rate release criterion of 5 $\mu\text{R/hr}$ above the determined mean background level in Reference 1 is satisfied. These measurements will be performed according to DD-CP-004, which states that measurements will be taken at the "corners and center of each room at contact and at 1 meter from the surface." Areas exceeding 10 meters in any direction will be divided into equal segments and exposure rate measurements taken in the center of each segment at contact and at 1 meter from the surface. Each segment shall not exceed 100 m^2 .

5.1.2 Gridding

Gridding is used to facilitate systematic selection of measuring/sampling locations, provide a mechanism for identifying areas, and provide a convenient means for determining average activity levels. Gridding will be conducted according to DD-CP-010, "Establishing a Surface Reference Grid for Walls, Floors, and Ceilings for a Detailed Characterization Survey." Grids will be approximately 1 meter by 1 meter.

5.1.3 Scanning and Indirect Surveys

Direct and indirect surveys will be performed on 100 percent of floors, walls (from the floor to 2 meters), and horizontal surfaces after exposure rate measurements and gridding of the area are completed. Any areas suspected to exceed 25 percent of the BCLDP guideline value listed in Reference 7 will be surveyed in the same manner as the floors and walls. Scanning is a survey technique performed by moving a detector at a consistent speed and distance above a surface for

the purpose of detecting elevated levels of radiation. Procedure DD-CP-004 requires direct surveys to be performed at a consistent scanning rate not to exceed 5 cm/sec and with the detector window less than or equal to 0.5 cm above the surface for the purpose of detecting elevated levels of radiation. If a reading above the DLV is indicated while scanning, the following additional data collection will be required:

- 1-minute static alpha + beta measurement at the point of highest activity
- 1-minute static alpha measurement at the point of highest activity
- Smear sample that will be analyzed for gross alpha, beta, and/or gamma activity.

Indirect surveys (smear samples) will be performed on a minimum of 10 percent of the remaining grids that did not have measurements exceeding the DLV.

5.1.4 Additional Samples

Drain, sump, and soil samples will be taken to further define the extent, if any, of residual radioactive contamination in the drainage systems and beneath facility structures. Analysis of samples by gamma spectroscopy will be performed by the BCLDP RAL or an approved outside laboratory. Additional sample analysis (i.e., gross alpha + beta, alpha spectroscopy, etc.) will be performed at the discretion of the Characterization Project Manager.

5.2 Remediation Control Surveys–Baseline Areas

Remediation control surveys will be performed in Buildings JN-1, JN-2, and JN-3, and others as needed. These buildings may be demolished as radiologically contaminated, (Reference 13 and Reference 14), which would negate the need for structural final status surveys. However, ground surveys still will be conducted at the building locations and included as part the site final status documentation. Ground surveys will be conducted in the manner described in Section 6 of this document.

5.2.1 Facility Surfaces

Remediation control surveys for facility surfaces consist of alpha + beta scans in and around the area of decontamination. These scans ensure that decontamination is effective and that radioactive contamination is not being spread to surrounding areas during the decontamination and demolition processes. Scans will be performed in the manner described in Section 5.1.3 of this document.

5.2.2 Soil Remediation Areas/Underground Drains

During the remediation of contaminated underground drains, the surrounding soil must be removed. Remediation control surveys for soil that is or has the potential for radioactive contamination will employ a combination of sampling and screening. Samples will be taken periodically as the soil is being removed. These samples will be screened using the process described in Section 4 of this document. Soil removal will continue until screening indicates that radioactive contamination is bounded and not present. Samples will be taken in the remediated

area and sent to the RAL for analysis to ensure that no radioactive contaminants above the volumetric release criteria in Reference 7 are remaining.

5.3 Final Status Surveys of Facility Surfaces – Baseline Areas

Final status surveys are required to determine the post-decontamination condition of a facility and provide data to demonstrate that unacceptable levels of residual radioactive contamination have not been left on-site. Final status surveys for the BCLDP baseline areas will be performed in accordance with procedure DD-CP-002 and are comprised of both scanning and population surveys.

5.3.1 Gridding

The grid system established during characterization also will be used during final status surveys. Grids in baseline areas will be divided into three categories: designated, adjacent, and non-designated. Designated grids are grids in which contamination was detected during the characterization process and are marked for decontamination and/or grids that were inaccessible during characterization. Adjacent grids are grids that border a designated grid. The remaining grids are considered non-designated.

5.3.2 Scanning

Scan surveys will be performed for designated and adjacent grids. If a reading above the DLV is indicated while scanning, the following additional data collection will be required:

- 1-minute static alpha + beta measurement at the point of highest activity
- 1-minute static alpha measurement at the point of highest activity
- Smear sample that will be analyzed for gross alpha, beta, and/or gamma activity.

The Characterization Project Manager will evaluate grids with activity levels meeting or exceeding 80 percent of the release criteria.

5.3.3 Population Surveys

A large population statistical survey shall be conducted for each designated, adjacent, and non-designated grid category. The statistical survey consists of a static alpha + beta integrated measurement, a static alpha-only integrated measurement, and a smear sample. The number of measurements for large area population surveys are determined by the chart below.

Total Number of Grids	Number of Grids to Receive Static Counts
< 30	100% of total grids
30 to 300	30 grids
> 300	10% of total grids

5.4 Characterization and Final Status Surveys of Facility Surfaces–

Non-Baseline Areas

Non-baseline areas are not expected to contain residual radioactive contamination. The final status surveys performed in support of non-baseline area characterization are designed to statistically show that the area is free from residual radioactive contamination and is suitable for release. Non-baseline building areas will be surveyed in accordance with DD-CP-025, "Facility Non-Baseline Final Status Survey," and Reference 1.

5.4.1 Gridding

Non-baseline areas do not require gridding. However, maps and/or floor plans will be used to identify survey and measurement locations.

5.4.2 Exposure Rate Measurements

Exposure rate measurements will be taken in the center of each room/area at a height of 1 meter above the floor surface. For areas exceeding 10 meters in any direction, the area will be divided into equal segments and a measurement will be taken in the center of each segment. Each segment shall not exceed 100 m². A smear sample also will be taken at each exposure rate measurement location.

5.4.3 Scanning

Scans in non-baseline areas will be conducted on a minimum of 10 percent of the floor and lower wall (floor up to 2 meters) surfaces. Scans will be performed in the alpha + beta mode of the instrument. Alpha-only scans may also be required in some areas. Surface activity measurements in excess of 25 percent of the release criteria will be evaluated by the Characterization Project Manager; these areas may require a more detailed survey.

5.4.4 Additional Samples

Samples will be taken from accessible drains and sumps. Analysis of samples by gamma spectroscopy will be performed by the RAL or an approved outside laboratory. Additional sample analysis (i.e., gross alpha + beta, alpha spectroscopy, etc.) will be performed at the discretion of the Characterization Project Manager. Samples with activity levels in excess of 25 percent of the release criteria will be evaluated by the Characterization Project Manager; these areas may require a more detailed survey.

5.4.5 Population Survey

A large population statistical survey also shall be conducted for floor and wall surfaces in each non-baseline area. The statistical survey consists of a static alpha + beta integrated measurement, a static alpha-only integrated measurement, and a smear survey. Static measurements will be taken at a minimum of 30 locations, or at a frequency of 1 measurement every 50 m², whichever is greater.

6.0 GROUNDS AND OPEN LAND AREA SURVEYS

The West Jefferson site grounds and open land areas must be surveyed in order to be released from radiological controls. The potential for radiological contamination will be evaluated, and the grounds will be classified as either affected or unaffected areas. The type and extent of radiological surveys will be determined by the area's classification.

Affected areas are those known or suspected to contain residual radioactive contamination. These areas will require characterization surveys, remediation control surveys, and final status surveys. Sample integrity will be maintained by using cross-contamination preventative measures and Chain-of-Custody described in SC-SP-004.2, "Manual Collection of Surface Soil Samples in Support of Site Characterization."

Unaffected areas are not expected to contain residual radioactive contamination. Therefore, a full characterization survey will not be required. Final status surveys will be necessary in order to release the area for unrestricted use. The paragraphs in Section 6.4 of this document describe the requirements for performing these surveys.

Various West Jefferson buildings housed baseline areas that had drain lines connected to exit sumps and piping to the site's sanitary and storm sewers. The BCLDP plans to monitor the underground sanitary and sewer lines using the Pipe ExplorerTM, which is owned and operated by SEA. Underground lines with activity meeting or exceeding release criteria will be excavated and removed. Soils surrounding the radioactively contaminated lines will be surveyed as described in Section 6.1.4 of this document.

6.1 Characterization Surveys – Affected Areas

For an area to be released from radiological controls, characterization surveys must be conducted to ensure that residual radioactive contamination levels are below BCLDP release criteria. These criteria are specified in Reference 7 and Reference 12. Data generated by previous surveys will be used to assess site conditions and to reduce survey costs. Characterization data will be used to supplement final status surveys.

6.1.1 Reference Grid System

A reference grid system is required by both NUREG/CR-5849 and DD-CP-004. The grid system is established to:

- Facilitate the selection of measurement/sampling locations
- Provide a mechanism for measurement/sampling location identification
- Provide a means for averaging activity levels (Reference 1).

The BCLDP will use a grid spacing for affected grounds of 10 meters by 10 meters. A contractor, approved per BCLDP Procedure QA-AP-7.1 by the DOE and the BCLDP, will perform the gridding.

6.1.2 Exposure Rate Measurements

Ambient external penetrating radiation measurements will be performed prior to characterization surveys. Outside areas require four measurements at 1 meter from the ground/surface per 100 m². Exposure rate measurements greater than two standard deviations above the mean value for background will require further evaluation by the Characterization Project Manager or designee.

6.1.3 Scanning

Scanning is a survey technique performed by moving a detector at a consistent speed and distance above a surface for the purpose of detecting elevated levels of radiation. BCLDP procedures require a survey rate not exceeding 5 cm/sec for paved outside areas. Alpha + beta scans of structural and paved surfaces will be performed with detector window less than or equal to 0.5 cm above the paved surface. Outside area scans of paved surfaces will be performed on all roads, parking lots, and walkways consistent with NUREG requirements. Scans will be conducted in accordance with DD-CP-004, which requires scanning 100 percent of the surveyable area. Stationary measurements will be taken in the alpha-only and alpha + beta modes for paved areas that exceed the DLV. If additional data indicate residual contamination levels above release criteria, the area of elevated activity will be bounded and marked for decontamination.

Walkover gamma scans of outside areas, paved and unpaved, will follow the NUREG/CR-5849 guidance of 50 cm/sec survey rate. Soil samples will be taken at each gamma walkover location that exceeds the DLV in unpaved areas. Soil samples will be taken under paved surfaces at the discretion of the Characterization Project Manager. Walkover and scanning surveys will be performed as part of characterization and final status surveys.

6.1.4 Soil Sampling

Soil sampling locations will be selected using the guidance in NUREG/CR-5849. Soil samples will be taken, by means of cross-contamination preventative measures, using 1-meter continuous core intervals, starting from the surface, down to 1 meter below the suspected or potential region of elevated activity. Samples will be taken in both paved and unpaved areas. Soil screening will be used to expedite the sampling process and to reduce analytical costs. Sample integrity will be maintained by using Chain-of-Custody described in SC-SP-004.2. Analysis of samples by gamma spectroscopy will be performed by the RAL or an approved outside laboratory. Additional sample analysis (i.e., gross alpha + beta, alpha spectroscopy, etc.) will be performed at the discretion of the Characterization Project Manager. If analyses indicate the presence of elevated levels of radioactive contamination in the soil, remediation may be required. Analysis that does not show elevated levels of radioactive contamination may be used during final status. All soil sampling will be performed in accordance with BCLDP Procedures SC-SP-004.2 and SC-SP-004.1, "Mechanical Collection of Surface and Subsurface Soil Samples in Support of Site Characterization."

6.2 Remediation Control Surveys – Affected Areas

6.2.1 Paved Surfaces

Remediation control surveys for paved surfaces consist of alpha + beta scans in and around the area of decontamination. These scans will be used to ensure that decontamination is effective and that radioactive contamination is not being spread to surrounding areas.

6.2.2 Soil Remediation Areas

Remediation control surveys for radioactively contaminated soil will employ a combination of sampling and screening. Samples will be taken periodically as the soil is being removed. These samples will be screened using the process described in Section 4 of this document. Soil removal will continue until screening indicates that radioactive contamination is adequately bounded and not present. Samples will be taken in the remediated area and sent to the RAL for analysis to ensure that no radioactive contaminants above the volumetric release criteria in Reference 7 are remaining.

6.3 Final Status Surveys – Affected Areas

Final status surveys provide data to demonstrate that unacceptable levels of radioactive materials have not been left on-site. The final status surveys performed in support of affected area characterization will be designed to statistically show that the specified area is free of residual radioactive contamination and suitable for release. Sample integrity will be maintained by using cross-contamination preventative measures and Chain-of-Custody described in SC-SP-004.2. These surveys will be planned and monitoring strategies detailed using NUREG/CR-5849, Section 4.2.3. The monitoring strategies are described in the following paragraphs. Data from previous surveys may be used to supplement the final status surveys.

6.3.1 Scanning

Outside area scans of paved surfaces will be performed where decontamination has occurred. Scans will be conducted in accordance with DD-CP-002, which requires scanning 100 percent of the remediated area. Stationary measurements will be taken in the alpha-only and alpha + beta modes for paved areas that exceed the DLV. If additional data indicate residual contamination levels above release criteria, the area of elevated activity will be bounded and marked for further decontamination.

Walkover gamma scans of outside areas, paved and unpaved, will follow the NUREG/CR-5849 guidance of 50 cm/sec survey rate. Soil samples will be taken at each gamma walkover location that exceeds the DLV in unpaved areas.

Scans conducted during characterization may be used for final status.

6.3.2 Static Measurements – Paved Surfaces Only

Static measurements are 1-minute counts performed with the detector stationary and less than or equal to 0.5 cm from the surface. Static measurements are part of the statistical aspect of the final status survey. This type of measurement technique is used in final status surveys to more accurately determine the residual activity levels in grids. Static measurements are performed in the alpha + beta and alpha-only modes for paved surfaces. Guidelines in NUREG/CR-5849 for affected areas state that measurements should be performed at a frequency of one measurement per 2 m² or 30 total measurements for each 100 m² survey unit.

6.3.3 Soil Samples

Final status soil samples will be taken in remediated areas at a frequency of one sample per square (or linear) meter. Analysis of samples by gamma spectroscopy will be performed by the RAL or an approved outside laboratory. Affected grids will be sampled to satisfy NUREG/CR-5849 by dividing the 10-meter by 10-meter grid into four quadrants. Samples will be obtained from the center of each of these quadrants.

6.4 Characterization and Final Status Operations—Unaffected Areas

Unaffected areas are not expected to contain residual radioactive contamination. Therefore, a full characterization will not be required. Final status surveys will be necessary in order to release the area for unrestricted use. The final status surveys performed in support of non-baseline area characterization will be designed to statistically show that the specified area is free of residual radioactive contamination and suitable for release. Sample integrity will be maintained by using cross-contamination preventative measures and Chain-of-Custody described in SC-SP-004.2. These surveys will be planned and monitoring strategies detailed using NUREG/CR-5849, Section 4.2.3, as guidance. These monitoring strategies recommended are detailed in the following paragraphs.

Unaffected areas will be reclassified as affected areas if activity levels exceed 25 percent of the applicable release criteria.

6.4.1 Exposure Rate Measurements

Ambient external penetrating radiation measurements will be performed prior to walkover surveys. Measurements for outside areas will require one measurement at 1 meter from the ground per 100 m². The specific location of the measurement will be determined by the layout of the area being characterized. Exposure rate measurements greater than two standard deviations above the mean background will require further evaluation by the Characterization Project Manager or designee.

6.4.2 Scanning

In NUREG/CR-5849, Section 4.2.3 recommends that gamma scans of unaffected areas cover a minimum of 10 percent of the outside ground areas. If scanning data indicate readings above the

DLV, samples will be taken at that location. The sample data will then be evaluated by the Characterization Project Manager or designee. If data indicate residual contamination levels that exceed 25 percent of the BCLDP release criteria, the area will be reclassified as affected and undergo full “affected area” characterization.

6.4.3 Unaffected Area Soil Sampling

To reduce sampling costs and maximize cost effectiveness, the BCLDP has complied with the DOE request to perform statistical sampling for groups of grids that did not have contaminated soils identified during the scoping survey (i.e., unaffected areas). Sampling populations will be defined for each unique area. The BCLDP will use the guidance in Section 8.5 of NUREG/CR-5849 which utilizes the comparison of the $\mu\alpha$ value (EPA 1989) to relate to a given limit value (C_G) at a desired confidence level (i.e., 95 percent) for demonstrating release. This statistical process can be performed only once. If it fails, the area must be remediated and the process must be redone. Given the guidance in Section 8.6, Equation 8-21 and Table B-2, if the scoping survey results are near background, six to ten samples per population area will be necessary to demonstrate the areas statistically satisfy release criteria at the 95 percent confidence level.

7.0 POST-CHARACTERIZATION OPERATIONS

The recorded results of all characterization and final status-related surveys will be compiled into related work instruction packages and retained by BCLDP Project Records. The accumulated work instruction data will be incorporated into a characterization and/or final status report. This report will serve as the documentation, supporting decontamination operations and ultimate release of the area from radiological controls. All documentation generated is reviewed and approved by characterization supervision or qualified designee.

8.0 TRAINING/QUALITY ASSURANCE

The performance of work in the field is overseen by a Certified Health Physicist and several National Registry of Radiological Protection Technologists (NRRPTs). Characterization personnel involved in surveying, monitoring, and/or data collection shall receive at a minimum:

- Basic radiation worker training in accordance with Section 8.0 of the BCLDP Radiation Protection Program (Reference 15)
- Task-specific training and qualification for the performance of BCLDP procedures.

Procedural training will be documented in accordance with BCLDP Procedure TD-AP-2.0, “Indoctrination, Training and Qualification.” In addition, industrial safety and industrial hygiene

orientation and training will be provided on specific topics such as the use of ladders, scaffolding, and elevated access equipment, as appropriate.

All data generated during survey performance are documented as required by the applicable procedure. These procedures include such steps as data review, audits, custody control of samples, and project records requirements.

9.0 INSTRUMENTATION

Monitoring instrumentation is calibrated using National Institute of Standards and Technology (NIST) traceable sources and controlled in accordance with ANSI-N323a, "Radiation Protection Instrumentation Test and Calibration" (Reference 16). Thorium-230 is used for α calibrations, Technetium-99 is used for β calibrations, and a commercially available mixed gamma source is used for λ calibrations. The emission energies of these isotopes are in the range of the energies from the expected nuclides, or in the case of Tc-99 are below, resulting in conservative calibration coefficients. Dose rate instruments are calibrated at an accredited off-site facility.

Survey instrumentation is performance tested for proper operation, within calibration ranges, at least once per day, as suggested in NUREG/CR-5849. These tests are documented on DDO-380, "Field Instrument Source Check," as part of procedure utilized for the work.

The following types of instruments may be employed in survey efforts:

- Gas proportional detectors and associated electronics sensitive to alpha and beta/gamma radioactivity and equipped with an aural indicator. These instruments may be operated in gas flow or static gas configuration and will be capable of detecting alpha-only and alpha + beta activity. Some electronics also may allow beta-only readings. Examples of gas proportional detectors are the Ludlum 239-1F floor monitor and the Eberline ESP-2 meter with a Ludlum 43-20 detector.
- Scintillation detectors and associated electronics sensitive to alpha, beta, or gamma radiation. These instruments may be capable of detecting both alpha and beta activity and discriminating between them. Examples of scintillation type instruments are the Delta 3/DP6 combination for alpha and beta detection/discrimination and a sodium iodide (NaI) crystal (Ludlum 12S Micro R meter) for gamma detection.
- A pressurized ionization chamber, MicroSpec, Micro R meter, or Geiger-Mueller instrument may be used to measure external penetrating radiation (gamma).
- A NaI detector (e.g., MicroSpec) and associated electronics may be used in the field for isotopic identification of contamination.
- A high purity germanium (HPGe) detector and associated electronics may be used in the laboratory for quantitative identification of contaminant isotopes in samples.

10.0 RADIOANALYTICAL SERVICES

The majority of samples collected in support of characterization activities will be analyzed at the Battelle RAL located in West Jefferson, Ohio. Gross alpha and gross beta analyses of smear and solid material samples will be performed using a simultaneous alpha and beta gas proportional counter. Gamma spectroscopy will be performed using a Canberra ProCount data acquisition system in conjunction with a HPGe detector. Alpha spectroscopy will be performed using Canberra Alpha Management System (AMS) in conjunction with a Canberra 7401 Passivated Implanted Planar Silicon (PIPS) detector. Analyses of samples with complex matrices or samples considered mixed waste will be performed by an approved off-site laboratory. Prior to solicitation, all outside vendor programs used for sample analysis are reviewed, approved, accredited, and placed on the DDO Approved Suppliers List in accordance with BCLDP Procedure QA-AP-7.1. Currently, General Engineering, in Charleston, South Carolina, is being utilized for off-site sample analysis.

11.0 PROCEDURES TO BE EMPLOYED FOR CHARACTERIZATION AND FINAL STATUS AT THE WEST JEFFERSON SITE

- HS-OP-001 Completion of the Industrial Safety Check List
- DD-CP-002 Facility Post-Decontamination Final Status Survey
- DD-CP-004 Radioactive Contamination Monitoring Requirements for Facility Surface Characterization
- DD-CP-007 Baseline Reference Values for Facility Radiological Characterization Surveys
- DD-CP-010 Establishing a Surface Reference Grid for Walls, Floors, and Ceilings for a Detailed Characterization Survey
- DD-CP-015 Use of a Gamma Scintillation Detector
- DD-CP-020 Field Isotopic Identification with a High Purity Germanium Detector
- DD-CP-025 Facility Non-baseline Final Status Survey
- DD-CP-030 Exposure Measurement Instrumentation Calibration, Performance Testing, and Use
- RL-AP-01.0 Administrative Operating Procedure for the Radioanalytical Laboratory (JN-2)
- TD-AP-02.0 Indoctrination, Training and Qualification

- QA-AP-7.1 Decontamination and Decommissioning Operations (DDO) Quality Department Administrative Procedure (QD-AP)
- QD-AP-5.2 Work Instructions
- SC-SP-004.1 Mechanical Collection of Surface and Subsurface Soil Samples in Support of Site Characterization
- SC-SP-004.2 Manual Collection of Surface Soil Samples in Support of Site Characterization
- SC-SP-006 Sampling of Sediment and Sludge for Chemical and Radiological Characterization

12.0 REFERENCES

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